Nose Shape of Indonesians: A Photogrammetric Analysis of Javanese and Minangkabau Children

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Abstract

This research aimed to analyse the nasal shape of Indonesian Javanese and Minangkabau tribes' children using lateral and frontal facial photographs and compare them with other ethnic populations.

Normal occlusion Javanese and Minangkabau children aged 12-14 years old were selected from junior high schools in Yogyakarta and Solok, Indonesia. Sixty-one Javanese and 62 Minangkabau children, 67 males and 56 females, were involved in this study. Standardised facial photographs were taken from frontal and lateral perspectives using a digital camera DLSR, 1000-pixel resolution. Linear and angular dimensions, nose height and width, canthal width, nasofrontal (NFA) and nasolabial angle (NLA), nose tip projection, and Goode's ratio were performed with CorelDRAW software from the digital facial photograph.

More than 75% of Javanese and Minangkabau children had mesorrhine noses, with an index of 75-77. No significant difference ($p > 0.05$) in nose width, length, NFA and NLA, ratio nose width (Al-Al) to canthal width was found between the groups. The nose width to canthal width was 1.2. A significant difference ($p < 0.05$) of the Goode's ratio value was also found between Javanese and Minangkabau and males and females. Compared with other ethnic groups, the Indonesian nose is similar to the Chinese, but with larger nasofrontal and nasolabial angles.

The nose of both Javanese and Minangkabau children were messorhine, with a greater Goode's ratio in Javanese than Minangkabau; and in males than females. Compared with other ethnic groups, Chinese was the closest, but with larger nasofrontal and nasolabial angles.

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Introduction

Facial analysis is important part in orthodontic and plastic surgery diagnosis. Face is composite of multiple attributes which are often united in harmony. Components of face which usually concerned and related with one performance are nose, lips and chin. Such as, Ricket with his E-line, Steiner with his S-line.

Positioned in the central and most prominent part of the face, the nose has a decisive influence on one's attractiveness. Nose size and shape vary by age and sex, as well as within and between ethnic groups and geographic regions of world populations.[1] Nasal width in European populations is significantly smaller than in Asian and African populations.[2] Similar differences were also found in the nasal index.[3]

Nasal index is the proportion of the width to the length of the nose, and it displays inter-group variation among human ethnic groups.[4] Based on the index, human nose shape can be classified into three major groups, namely Leptorrhine or fine nose with an index <70; Mesorrhine or medium nose with an index between 70.0-84.9; and Platyrrhine or broad nose with an index >85.0.[5]

With respect to personal attractiveness, analysis of nasal variation should consider the position of the nose relative to its neighbouring structures, as well as the size and shape of the nose.[6] In the perception of attractiveness, harmony within the structures or parts of the face

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is of the utmost importance.[7] Harmony is a pleasing and equal combination of two or more related attributes which produce an attractive appearance.[8] Thus, in facial attractiveness, the most important feature is not the size or shape alone but how components of face are balanced in combination.

Indonesia is an archipelago consisting of 16,766 islands that are located between the continents of Asia and Australia.[9] Indonesian islands are inhabited by more than 300 tribes and speak more than a hundred and ten languages.[10] The population of Indonesia consists of two main groups, Proto Melayu and Deutero Melayu, which are within the Australomelanesan and East Asian populations, respectively. They inhabited separate islands for thousands of years, and different environments resulted in physical changes.[11] The Javanese population lives mainly on the island of Java and is the majority population of Indonesia (41%). While the Minangkabau tribe inhabit a province West of Sumatra and Riau, the western part of Sumatra Island. The population is about 2.73% of Indonesian.[10] Both Javanese and Minangkabau tribes are included in a subgroup called the Deutero-Melayu, but they live in different environments, have diverse lifestyles, and have had dissimilar cultures for a long period of time.[11]

Studies have shown that the biological attributes of human populations are influenced by climatic, geographic and environments in which they live. For example, a cephalometry study on Indonesian Javanese, Batak and Chinese who live in Jakarta showed that the bigonial width of the Batak was significantly wider in comparison with Javanese and Chinese, although all are Asian groups.[12] A photogrammetric study of the facial profiles of high school students in Medan, Sumatra, Indonesia revealed that 64% straight, 20% convex and 16% concave. [13]

This phenomenon might also be present in Javanese and Minangkabau tribes. Published data on the facial form, especially variation in nasal size and shape of Indonesian is lacking. The purpose of this study was to analyse nasal variation in Indonesian Javanese and Minangkabau tribes' children using facial photographs (frontal and lateral views) and to compare them with other ethnic populations.

Materials and methods

Subjects between 12-14 years old were selected from junior high school students in Yogyakarta for the Javanese tribe and in Tanjung Paku Solok, West Sumatra for the Minangkabau tribe (Figure 1).

Figure 1. Indonesia's map: location of the subjects' data collection.

Seven criteria were used in selecting Javanese and Minangkabau students, they included: a) Javanese descent and Minangkabau descent (2 generations); b) class I molar relationship; c) body mass index between 14.6 and 25.8; d) all the permanent teeth had erupted (except third molars); e) no facial deformities or trauma history; f) good tooth alignment with normal overjet; and g) no orthodontic treatment.

This study has been approved by the ethical committee of the Faculty of Dentistry Gadjah Mada University, Yogyakarta (Number: 0086/KKEP/FKG-UGM/EC/2014). Informed consent from the parents or guardians and the class's teachers. Facial photographs were taken from frontal and lateral (left side) views. A ruler was included in each image for calibration. A digital camera DLSR Canon EOS 60D, with 1000-pixel resolution was used for photography. The subject was seated on a chair in straight position, Frankfurt horizontal plane parallel to the floor, the head was held by a cephalostat with ruler attached. The camera (microlens) was put on a static tripod, positioned at a distance of 156 cm from the nose tip of the subject. The landmark points, G (glabella), N (nasion), Or (infraorbital) were made on the subject's faces using an eyebrow pencil.

Linear and angular dimensions were measured with Corel draw graphics program from the digital facial photograph, after editing with Adobe Photoshop (Adobe Inc., San Jose, CA, USA) to confirm the similarity measurement

between the photo and the subject. All measurements were obtained by the first author. The following measurements were evaluated from frontal and lateral views of facial photographs.

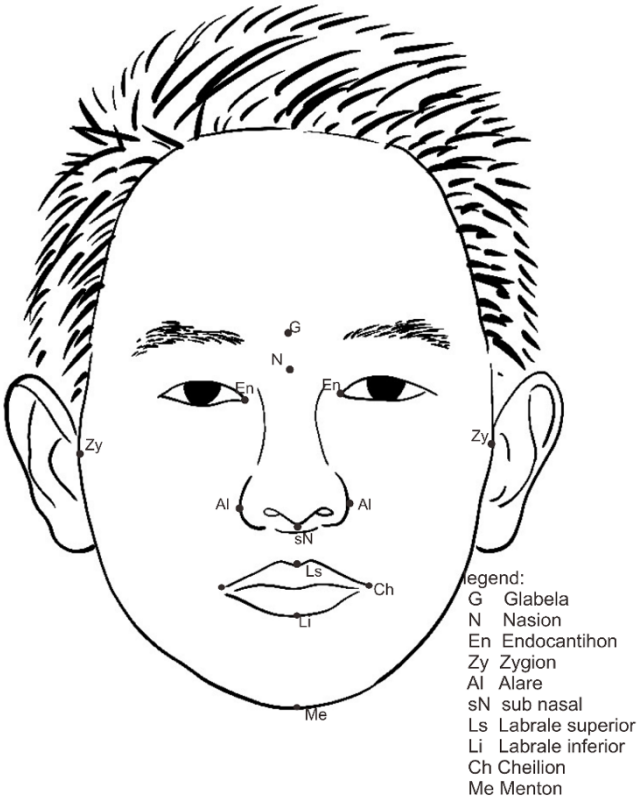

Figure 2. Frontal view of facial photograph landmark.

Facial frontal view (Figure 2)

1. Nose height, nasion to sub-nasion (N'-sN')
2. Nose width, left alare to right alare (Al-Al)
3. Intercanthal width, left endocanthion (En-En)

Al: the most lateral point on the curved surface of each alare.

Lateral view of facial landmarks (Figure 3)

1. Nasofrontal angle (NFA), obtained by drawing a line tangent to the glabella through the nasion that will intersect a line drawn tangent to pronasal.
2. Nasolabial angle (NLA), angular inclination of the columella at the point where it meets the upper lip (labrale superior, Ls)
3. Nose tip projection (ac-Pr), distance between the ala crest point (the most lateral spot on the curved base line of the ala) to pronasal.

Proportion indices

1. Nasal index = $\frac{Al-Al}{N-subN} \times 100\%$
2. Goode's ratio = $\frac{Pr-Pr'}{N-Pr}$ x 100%
3. Al-Al / En-En

Sex dimorphism was computed from the formula:

Sex dimorphism=$\frac{mean\ value\ in\ males - mean\ value\ in\ females}{mean\ value\ in\ females}\ x\ 100\%$

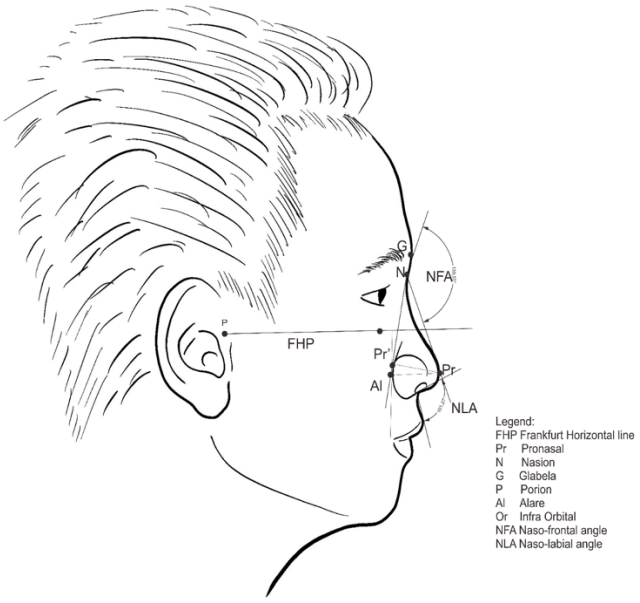

Figure 3. Lateral view of facial photograph landmark.

The data were analysed using SPSS 25 for Windows with confidence interval 95%, including descriptive data, mean, standard of deviation, minimum and maximal values, and student t-test for comparing the mean value between males and females, and between the two ethnics groups.

Results

Sixty-one Javanese children (36 males and 25 females) and 62 Minangkabau children (31 males and 31 females) were enrolled in the study. The distribution of nose morphology for the Javanese and Minangkabau tribes is shown in Table 1. The most common nasal index in both tribes was mesorrhine or medium nose, more than 75%. Less than 10% of Javanese had a leptorrhine or fine nose, while leptorhine was 10-17% for the Minangkabau tribe.

Data for the mean, standard deviation, minimum and maximum measurements, sexual dimorphism, and the probability values of *t*-tests are presented in Table 2. On average the Javanese nose tip projection, as well as the Goode's ratio, in males was significantly higher than in females ($p < 0.05$), namely 23.54 mm (± 3.23 mm) and 21.80 mm (± 2.61 mm) respectively. However, in Minangkabau the males had shorter noses than females, namely 16.68 (± 2.23) and 18.11 (± 2.73) respectively, these values are not significantly different ($p > 0.05$). Significant sexual dimorphism was found in Goode's ratio for both tribes. No significant differences were found in the nasofrontal and nasolabial angles between males and females both in Javanese and Minangkabau tribes. The ratio between nose width / canthal width were about 1.18 both in males and females for both tribes.

Categories	Javanese		Minangkabau		Total	
	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)
Leptorrhine	8.3	8.7	16.7	10.0	11.9	11.1
Messorrhine	86.1	73.9	66.7	83.3	76.1	77.8
Platyrrhine	5.6	17.4	16.7	6.7	11.9	11.1

Table 1. Distribution of nose morphology in javanese and minangkabau males and females in %.

Legend: Leptorrhine nasal index ≤69.9
Messorrhine nasal index 70.0 – 84.9
Platyrrhine nasal index ≥85.0

Measurements	Males		Females		Sex Dim (%)	t-test
	Mean ± SD	Range	Mean ± SD	Range		
Javanese children (males=36; females=25)						
Nose index	75.86 ± 5.57	60.88 - 87.27	77.95 ± 6.56	66.42 -89.06	2.68	-1.31
Nose width	39.36±3.71	30.80-47.84	38.59±2.84	32.64-44.65	2.00	0.85
Nose tip projection	23.54 ± 3.23	16.36 - 33.18	21.80 ± 2.61	16.58 - 28.26	7.98	2.25*
Goode's ratio	0.48± 0.05	0.36 – 0.61	0.45 ± 0.05	0.36 – 0.54	7.19	2.61*
Al-Al/En-En	1.18±0.10	1.01-1.36	1.19±0.09	1.02-1.33	0.39	0.70
NFA	143.67 ± 5.05	129.11 - 151.98	144.02 ± 5.98	131.72 - 154.02	0.24	-0.25
NLA	102.58±11.47	73.29 - 127.32	100.15 ± 11.68	84.88 - 122.97	2.43	0.81
Minangkabau children (Males=31; Females=31)						
Nose index	77.44 ± 7.05	66.70 - 92.03	75.29 ± 5.92	60.32 - 87.60	2.86	1.30
Nose width	39.19±2.94	34.39-46.85	38.40±2.87	32.91-45.14	2.06	1.07
Nose tip projection	16.68 ± 2.23	12.35 - 21.55	18.11 ± 2.73	12.49 - 23.17	7.90	-0.28
Goode's ratio	0.43 ± 0.05	0.36 – 0.56	0.39 ± 0.05	0.27 – 0.47	9.65	2.93*
Al-Al/En-En	1.19±0.12	0.93-1.52	1.18±0.12	0.96-1.44	0.29	0.77
NFA	141.99 ± 7.12	128.47 - 154.36	143.48 ± 7.41	118.90 - 154.89	1.04	-0.80
NLA	99.05 ± 11.34	73.90 - 121.12	100.45 ± 10.69	82.40 - 120.41	1.39	-0.50

Table 2. Mean, standard deviation, range, sex dimorphism, and student t-test of the nose measurements of Indonesian Javanese and Minangkabau tribes children males and females.

Legend: 1) nose tip projection in millimeter, 2) angle in degree; *p<0.05 statistically significant. Al-Al: nose width, En-En: canthal width NFA: naso-frontal angle; NLA: naso-labial angle.

Comparation of the mean measurements is provided in Table 3, which shows the equality between Javanese tribes and Minangkabau tribes in males and females with *t*-test results. A significant difference ($p < 0.05$) in nose tip projection and Goode's ratio both in males and females, where Javanese children have higher nose protrusion than the Minangkabau.

Index	Sex	Javanese x±SD	Minangkabau x±SD	t-test	p
Nose index	Male	75.86±5.57	77.44±7.05	-1,02	0,31
	Female	77.95±6.56	75.29±5.92	1,56	0,13
Nose width	Male	39.36±3.71	39.19±2.94	0.21	0.83
	Female	38.59±2.84	38.40±2.87	0.25	0.81
Nose tip projection	Male	23.54±3.23	16.63±2.23	9,86	0.00*
	Female	21.80±2.61	18.11±2.73	5,11	0.00*
Goode's ratio	Male	0.48±0.05	0.43±0.05	4,61	0.00*
	Female	0.45±0.05	0.39±0.05	4,29	0.00*
Al-Al/En-En	Male	1.18±0.10	1.19±0.12	-0.44	0.66
	Female	1.19±0.09	1.18±0.12	0.23	0.82
NFA	Male	143.67±5.06	141.99±7.12	1,13	0,27
	Female	144.02±5.98	143.48±7.41	0,29	0,77
NLA	Male	102.58±11.47	99.05±11.34	1,26	0,21
	Female	100.15±11.68	100.45±10.69	-0,10	0,92

Table 3. Student t-test for equality of mean nasal measurements in males and females of indonesian javanese and minangkabau tribes' children.

Legend: 1) nose tip projection in millimeter, 2) angle in degree; *p<0.05 statistically significant. Al-Al: nose width, En-En: canthal width. NFA.: nasofrontal angle; NLA: nasolabial angle.

Ethnic/nation	Author/year	subject age (years)	Males			Females		
			Lepto	Messo	Platy	Lepto	Messo	Platy
Serbia[14]	Jovanovic et al., 2014	18-65	68.32	29.77	1.91	87.18	11.97	0.85
Turkey[15]	Uzun & Ozdemir, 2014	18–30	73	25	2	88	12	0
Iran[5]	Dhulqarnain et al., 2019	16-60	55	40	5	73	22	4
India[16]	Kulkarni et al, 2019	18-25	22.45	79.59	16.33	34.55	56.36	9.09
Kathmandu[17]	Bajracharya & Sharma, 2019	17-25	15	67.5	17.5	13.7	73.8	12.5
Nigeria[18]	Mohammed et al., 2018	16-60	25	71	4	50	49	1
Bini Nigeria[19]	Rotimi et al., 2019	5 – 12	0	30	70	0	32	68
Indonesia	Kuswandari et al., 2022	12–14	11.9	76.2	11,9	11.1	77.8	11.1

Table 4. Distribution of the type of nose morphology base on the ethnic/ nation in %.

Table 4 provides a comparison of nose morphology type in Indonesia with other ethnic groups, including Serbian, Nepali (Kathmandu), Iran, Nigeria. These data show that the form of Nepali (Kathmandu) nose type is most similar to Indonesians, with the mesorrhine type averaging 67.5% in males and 73.8% in females.

Discussion

One of important facial decisive aspects is the nose. Consequently, it is critical to include nasal size and shape in facial analyses, including not only size and shape, but its relation to the neighbouring parts as a harmony. For this purpose, photogrammetry or facial photography is a reliable analytic tool since facial landmarks can be consistently located.[14] This method is not invasive and practical for epidemiologic studies of large populations and insures reliable and reproducible results. However, photogrammetry might result in minor distortion, even when a standardization protocol had been used. The size of the image can vary a few millimetres from one photograph to another. It is advisable that certain measurements are obtained at specific angles give more reliable and accurate results. This problem can be eliminated using ratios and angles between the primary landmarks and measures.[15]

This analysis of nasal shape using frontal view photogrammetry shows that as in other Asian populations, nose morphology in both Indonesian Javanese and Minangkabau children were mesorrhine or medium nose (more than 75%), with average index of 75 to 78, compared with the Caucasoid average index 54 to 64.[2] When compared with other groups (Table 4) the position of Indonesians was near Indian and Nepali (Kathmandu) populations. The Caucasoid, Serbian, Turkish and Iranian samples, are mostly leptorrhine (tall and narrow nose). Nose shape differences across these human population might be result of local adaptation to the climate.[16] As reports significant correlation between nasal cavity shape and climate, both temperature and humidity.[17] The shape changes are functionally consistent with increasing contact between air and mucosal tissue in cold-dry climates due to greater turbulence during inspiration and a higher surface-to-volume ratio in the upper nasal cavity. While breathing in hot and humid climates does not require warming and humidifying of the incoming air, it is less stressful in terms of air conditioning in maintaining lung function. And the internal nasal dimensions may be linked to the width and breadth of the external nose.[3] Populations from cold and dry environments have tall and narrow noses or low nasal indices, while populations from hot and humid environments have short and broad noses or high nasal indices. Javanese and Minangkabau children although they live in separate places, the climate is almost similar, around equator, with hot and humid environment. Table 5 shows that the differences in Al-Al among the groups are more obvious than N'-sN. The nose width of Indonesian and Chinese were almost similar. It might be because Indonesian and Chinese are both Asian populations. Among the groups compared, Caucasian nasal width is the smallest, the African American was largest, while Indonesian and Chinese were in between Caucasian and African American.

The males' nose tip projection in Javanese was significant longer than females ($p < 0.05$). This sexual dimorphism is also found in internal and external nasal morphology, which relates to respiratory performance, such as conditioning, moistening and gas exchange.[3,18] Oxygen consumption and pulmonary capacity of males are higher than females.

On the contrary, the Minangkabau females' nose tip projections were longer than the males, although the difference was not significant. It might be partly explained by the subject's age in this study, 12-14 years, when actively growing. The females are typically earlier than the males in the timing of growth and development. Some of females might have finished their growth spurt, while the males have just started. However, males have a longer growth spurt than females.[19] The Javanese subjects were come from the city of Yogyakarta, which is associated with more modern and freer young interrelationships and more entertainment facilities. By contrast, the Minangkabau subjects come from a rural area, Tanjung Paku, Solok. Research suggests that the physical growth rate of children is affected by seasonal and social factors. City children tend to mature faster than rural ones, especially in less developed countries.[19] External stimuli, such as social factors, influenced the secretion rate of gonadotropin-releasing factors, which is mediated via the hypothalamus. The activity of

gonadotropin-releasing hormone (GnRH) induces the physiologic events of puberty.[20] During childhood the activity of GnRH is very low and become high at puberty or adolescence. The stages of adolescent development are correlated with growth in height, as well as growth of the jaws and the nose. The nasal structures undergo the same passive displacement as the rest of the maxilla.[21] However, the nose grows more rapidly than the rest of the face, particularly during the adolescent growth spurt. Nasal growth is produced in part by an increase in size of the cartilaginous nasal septum. In addition, proliferation of the lateral cartilages alters the shape of the nose and contributes to an increase in overall size. On average, nasal dimensions increase at a rate about 25% greater than growth of the maxilla during adolescence, but growth of the nose is extremely variable among ethnic groups and quite variable within those groups.[19] It was also relation with the Goode's ratio values of these subjects. Goode's ratio is one of tools for analysed the nasal tip projection by comparing with the dorsum length (N'-Pr). The mean of Goode's ratio in Javanese males and females were 0.48 and 0.45 respectively; and in Minangkabau were 0.43 and 0.39 respectively. When compared with the ratios for Caucasians, 0.55-0.60 (Powell, n.d.) the Indonesian nose is much less projective.

Harmony in size and position of the nose to the neighbouring parts of the face is one of several important factors in facial analysis. The ratio between Al-Al and En-En of Javanese and Minangkabau children, both males and females are not different, namely 1.18. The alar width is greater than canthal width, while the ideal ratio is equal to 1. This study agrees with whose analysis of healthy Caucasians that 90% the ratio between alar width and canthal width was more than 1.[22]

The relationship of the nose with frontal brow ridge and upper lip were analysed by measuring NFA and NLA. Compared with the normative values of Chinese, Caucasoids and African American (Table 5) the NFA both Javanese and Minangkabau children were larger than the Chinese and the other ethnics, with average more than 140 degree.[6,23] In Caucasoid the NFA range is 115-130 degrees.[21] It means the Indonesian NFA was more obtuse. Unfortunately, it was not known which components as cause factor, the lower or the upper components of the angle. The normal value upper component of NFA is 60-75 degrees; while the lower component is 55 degrees (6). The magnitude of NFA upper component is depend on the variation of the brow ridge, while the lower is depends on the nasal dorsum.

The NLA mean values of Indonesian were closer to Caucasoid than Chinese, namely 100.69 ± 11.23 degrees. The Indonesian NFA was in the range of Powell suggestion, namely 90 to 120 degrees. However, the males are not more acute than the females. The NLA magnitude will depend on the inclination of nasal columella for the upper component and upper lip for the lower component. These components will be better assessed separately, the upper and the lower part of true horizontal line through sub nasal.

Conclusions

The majority of Javanese and Minangkabau children have mesorrhine noses, with a mean nasal index between 75 and 77, and widths between 38- and 39 mm. Goode's ratio of males was greater than females, and the Javanese was greater than Minangkabau, with average values of 0.48 and 0.45 in Javanese males and females; and 0.43 and 0.39 in Minangkabau males and females, respectively. No differences were found in nasofrontal and nasolabial angles. Compared to other ethnic groups, the Indonesian nose was most similar to Chinese, wider than Caucasian but narrower than African.

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Declaration of Interest

The authors declare no conflict of interest in this study.

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